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LAMINATED FILM AND CONDENSER USING THE SAME
[Sekiso firumu oyobi sore wo mochiita kondensa]

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(54) [Title of the Invention]

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Laminated Film and Condenser Using the Same

[Claim(s)]

[Claim 1] A laminated film being characterized in that the surface layer comprising a polyester polymer is formed on at least one side of a film comprising a styrene polymer having a syndiotactic structure.

[Claim 2] The laminated film cited in Claim 1 being characterized in that the three-dimensional surface roughness SRa of the surface layer is $0.01\text{ }\mu\text{m}$ or higher and the $S\lambda a\text{ }\mu\text{m}$ and the glass transition temperature satisfy the following relationship:

$$4+4 \times (T_{ge}-T_{gc})/T_{ge} \leq S\lambda a \leq 25+10 \times (T_{ge}-T_{gc})/T_{ge}$$

(where T_{ge} is the glass transition temperature of polyethylene terephthalate and T_{gc} is the glass transition temperature of the surface layer).

[Claim 3] The laminated film cited in Claim 1 wherein the glass transition temperature of the surface layer satisfies the following relationship:

$$T_{gc} \geq 50 \times (1+A_e/A)$$

(where A_e is the thickness of the surface layer and A is the thickness of the laminated film).

*Claim and paragraph numbers correspond to those in the foreign text.

[Claim 4] The laminated film cited in Claim 1 being characterized in that the thickness of the surface layer is 30% or less of the thickness of the laminated film.

[Claim 5] The laminated film cited in Claim 1 being characterized in that the dielectric tangent (25°C, 1 kHz) of the laminated film is 0.001 or less.

[Claim 6] A condenser being characterized in that a metalized syndiotactic polystyrene laminated film having a metal thin film layer formed on at least one side of the syndiotactic polystyrene laminated film cited in Claim 1 is used.

[Detailed Specifications]

[0001] [Field of Industrial Application]

The present invention relates to a laminated film and a condenser using the same, and in further detail, a syndiotactic polystyrene laminated film that is ideal as a dielectric film for a condenser, is outstanding in film running properties and shaving resistance during manufacture of the film and manufacture of the condenser, and whose humidity resistance and self-healing properties are improved when a voltage is applied, and a condenser.

[0002] [Prior Art]

Biaxially drawn films obtained by biaxially drawing and thermally fixing a resin composition composed mainly of a syndiotactic polystyrene polymer have been developed as dielectrics of condensers since their heat resistance and electric

characteristics are excellent (JP-A (Tokukai) Nos. H02-143851, H03-124750, and H05-200858). Moreover, films having improved smoothness owing to improvements in the running properties and yield during manufacture of a condenser are known (JP-A (Tokukai) Nos. H06-29146, H06-80793).

[0003] [Problems to be Solved by the Invention]

However, although improvements in the shaving resistance and running properties of these conventional syndiotactic polystyrene films during the manufacture of a film and the manufacture of a condenser have been observed, the humidity resistance and self-healing properties have not been entirely satisfied when a voltage is applied to the resultant condenser.

[0004] [Means for Solving the Problems]

The present invention is a laminated film being characterized in that the surface layer comprising a polyester polymer is formed on at least one side of a film comprising a styrene polymer having a syndiotactic structure. Furthermore, this three-dimensional surface roughness S_{Ra} of the surface layer is 0.01 μm or higher, and the S_{λa} μm and the glass transition temperature satisfy the following relationship:

$$4+4 \times (T_{ge}-T_{gc})/T_{ge} \leq S_{\lambda a} \leq 25+10 \times (T_{ge}-T_{gc})/T_{ge}$$

(where T_{ge} is the glass transition temperature of polyethylene terephthalate and T_{gc} is the glass transition temperature of the

surface layer); the glass transition temperature of the surface layer satisfies the following relationship:

$$T_g \geq 50 \times (1 + A_e/A)$$

(where A_e is the thickness of the surface layer and A is the thickness of the laminated film); the thickness of the surface layer is 30% or less of the thickness of the laminated film; the dielectric tangent (25°C, 1 kHz) of the laminated film is 0.001 or less, whereby a syndiotactic polystyrene laminated film can be obtained. It is ideal as a dielectric film for a condenser, suppresses the loss of a lubricant, and is outstanding in film running properties and shaving resistance during manufacture of the film and manufacture of the condenser, and its humidity resistance and self-healing properties are improved when a voltage is applied. Moreover, the condenser being characterized in that such a syndiotactic polystyrene laminated film is used is outstanding in electrical characteristics, and is outstanding in humidity resistance and self-healing properties when a voltage is applied.

[0005] It is desirable that the polystyrene polymer used in the present invention having a syndiotactic structure with stereoregularity be a syndiotactic structure with a tacticity wherein the phenyl group or substituted phenyl group of a side chain are quantified in a nuclear magnetic resonance method 85% or greater for a diad (two configured units) and 50% or greater for a pentad (five 5 configured units).

[0006] Polystyrene; poly(alkyl styrenes), such as poly(p-, m- or o-methyl styrene), poly(2,4-, 2,5-, 3,4-, or 3,5-dimethyl styrene), and poly(p-tert-butyl styrene); poly(halogenated styrenes) such as poly(p-, m-, or o-chlorostyrene), poly(p-, m-, or o-bromostyrene), poly(p-, m-, or o-fluorostyrene), and poly(o-methyl-p-fluorostyrene); poly(halogen-substituted alkyl styrenes), such as poly(p-, m-, o-chloromethyl styrene); poly(alkoxystyrenes), such as poly(p-, m-, or o-methoxystyrene) and poly(p-, m-, or o-ethoxystyrene); poly(carboxyalkyl styrenes), such as poly(p-, m-, or o-carboxymethyl styrene); poly(alkylsilyl styrenes), such as poly(p-trimethylsilyl styrene); and further, poly(vinylbenzyl dimethoxyphosphides); and the like are cited for the polystyrene polymer.

[0007] In the present invention, polystyrene is especially ideal from among the aforesaid polystyrene polymers. Moreover, the polystyrene polymer having the syndiotactic structure used in the present invention need not always be a single compound; it may be a mixture or copolymer of polystyrene polymers having atactic and isotactic structures, or a mixture thereof as long as the syndiotacticity falls in the aforesaid range. Moreover, the weight average molecular weight of the polystyrene polymer used in the present invention is at least 10,000, and more preferably, at least 50,000. When the weight average molecular weight is less than 10,000, a film outstanding in strength and elongation characteristics and heat resistance may not be obtained. The upper limit of the weight

average molecular weight is not limited in particular, but it is not preferable at all if it is 1,500,000 or higher because the occurrence of breakage in association with an increase in the drawing tension and so forth develops.

[0008] Furthermore, known methods, e.g., drawing methods, such as successive biaxial drawing methods in which a longitudinal drawing and transverse drawing are performed in that order, as well as a transverse-longitudinal-longitudinal drawing method, a longitudinal-transverse-longitudinal drawing method, and longitudinal-longitudinal-transverse drawing method, may be adopted for the syndiotactic polystyrene film of the present invention, and may be selected depending on the various characteristics required, such as strength and dimensional stability. Moreover, a thermal fixing method, longitudinal relaxation treatment, transverse relaxation treatment, and the like may be carried out.

[0009] Additives wherein suitable amounts of known antioxidants, antistatic agents, and the like have been compounded may be used, as needed, in the syndiotactic polystyrene used in the present invention. the compounding amount is desirably 10% by weight or less with respect to 100% by weight of the syndiotactic polystyrene polymer. It is not preferable if it exceeds 10% by weight because breakage readily arises during drawing, and the production stability becomes defective.

[0010] A method in which the syndiotactic polystyrene polymer and a surface-forming resin composition are joined inside a die or at the opening of the die in a melted state, laminated, extruded from the die, and quenched to fabricate an amorphous sheet, and subsequently drawn, a method in which the syndiotactic polystyrene polymer is drawn from the die, quenched, and a surface-forming resin composition is coated on the resultant amorphous sheet or a biaxially drawn film, and subsequently further drawn, a method in which individually drawn films are respectively adhered and superimposed, and other methods are cited for the method for forming the surface layer.

[0011] The polyester resin laminated on the syndiotactic polystyrene system of the present invention includes polyester polymers, polyester copolymers, mixtures of these, etc. The dicarboxylic acid constituent thereof includes respective aromatic, aliphatic, and alicyclic dicarboxylic acids. Terephthalic acid, isophthalic acid, orthophthalic acid, 2,6-naphthalene dicarboxylic acid, and the like may be cited for the aromatic dicarboxylic acid. It is preferable that the percentage of these aromatic dicarboxylic acids be 40% by mole or more of all the dicarboxylic acid constituents. When the percentage is less than 40% by mole, the mechanical strength and water resistance of the polystyrene resin decline. Succinic acid, adipic acid, sebacic acid, 1,3-cyclopentane dicarboxylic acid, 1,2-cyclohexane dicarboxylic acid, 1,3-cyclohexane

dicarboxylic acid, and the like are cited for the aliphatic and alicyclic dicarboxylic acids. When aliphatic and alicyclic dicarboxylic acids are added, the adhesion performance may be enhanced, but in general, the mechanical strength and water resistance of the polyester copolymer decline.

[0012] A glycol constituent is an aliphatic glycol having 2 to 8 carbons, its alicyclic glycol having 6 to 12 carbons, and a mixture thereof; ethylene glycol, 1,2-propylene glycol, 1,3-propane diol, 1,4-butane diol, neopentyl glycol, 1,6-hexane diol, 1,2-cyclohexane dimethanol, 1,4-cyclohexane dimethanol, p-xylene glycol, and the like are cited therefor. Diethylene glycol, triethylene glycol, and the like are cited for the aliphatic diol having 4 or more carbons. Moreover, polyethylene glycol, polypropylene glycol, polytetramethylene glycol, and the like are cited for polyethers.

[0013] The polyester resin is obtained by performing the usual melting and polycondensation. That is to say, it is obtained in a direct esterification method in which the aforementioned dicarboxylic acid constituent and glycol constituent are directly reacted, the water is distilled, esterified, and a polycondensation is subsequently performed, or an ester exchange method in which the dicarboxylic acid constituent, a dimethyl ester, and the glycol constituent are reacted, methyl alcohol is distilled, an ester exchange is performed, and polycondensation is subsequently performed. In addition to this, the polymer can also be obtained in a melt

polycondensation method or interfacial polycondensation method. The present invention is not limited to any of the above-mentioned methods. During a melt polycondensation, an antioxidant, lubricant, inorganic fine particles, and antistatic agent may be added, as needed. The aforementioned polyether may be added during the melt polycondensation or by blending it after polymerization.

[0014] The surface layer of the laminated film of the present invention comprising a polyester polymer is formed on at least one side of the film comprising a styrene polymer having a syndiotactic structure. By forming a surface layer comprising the polyester polymer, the humidity resistance and self-healing properties become excellent. Moreover, since the electrical characteristics of the polyester resin are relatively excellent, the temperature and frequency dependence of the extremely satisfactory electrical characteristics of the syndiotactic polystyrene polymer are affected little.

[0015] The aforementioned three-dimensional surface roughness $S\lambda a$ and surface roughness SRa are adjusted according to the film-forming conditions, the protrusion-forming agent(s), lamination, etc. The type of the protrusion-forming agent(s) and the amount added are not especially limited as long as the three-dimensional surface roughness $S\lambda a$ and surface roughness SRa fall within the predetermined ranges. But the addition of particles comprising metal oxides, such as silica, titanium dioxide, talc, kaolinite, and

zeolite; metal salts, such as calcium carbonate, calcium phosphate, and potassium sulfate; or organic polymers, such as silicone resins and crosslinked polystyrenes is exemplified, for example. Any one kind of these fine particles may be used singly, or two or more of them may be combined. However, the average particle diameter [misspelled in original as 'system'] of the fine particles used is preferably at least 0.01 μm to at most 2.0 μm , and in particular, at least 0.05 μm to at most 1.5 μm . The degree of variation in the particle diameter (ratio of the standard deviation and average particle diameter) is preferably 25% or less. It is preferable that the amount added be at least 0.005% by weight to at most 2.0% by weight, and in particular, at least 0.1% by weight to at most 1.0% by weight with respect to 100% by weight of the syndiotactic polystyrene polymer.

[0016] The three-dimensional surface roughness SRa of the syndiotactic polystyrene laminated film of the present invention is at least 0.01 μm , and more preferably, at least 0.02 μm . It is not preferable when the SRa is less than 0.01 because the running properties during manufacture of the film and manufacture of the condenser is defective. Moreover, it has been seen that the most suitable range of the three-dimensional surface roughness $\text{S}\lambda\text{a}$ for suppressing loss of lubricant during running of the film and manufacture of the condenser and making the film into an article having outstanding running properties varies depending on the glass

transition temperature of the laminated film, and it had to fall within the below-mentioned range:

$$44 \times (T_{ge} - T_g) / T_{ge} \leq S\lambda_a \leq 25 \times 10 \times (T_{ge} - T_g) / T_{ge}$$

(where T_{ge} is the glass transition temperature of polyethylene terephthalate and T_g is the glass transition temperature of the surface layer).

When the $S\lambda_a$ is less than $44 \times (T_{ge} - T_g) / T_{ge}$, the running properties is defective. Furthermore, it is not preferable when the $S\lambda_a$ is larger than $25 \times 10 \times (T_{ge} - T_g) / T_{ge}$ because white powder is generated in association with shaving of the protrusions so the wear resistance is unsatisfactory.

[0017] It was seen that the glass transition temperature of the surface layer in the present invention affected the electrostatic capacity of the laminated film and the dielectric tangent temperature and frequency characteristics depending on the thickness of the surface layer, and it had to fall within the following range:

$$T_{gc} \geq 50 \times (1 + A_e/A)$$

(where A_e is the thickness of the surface layer and A is the thickness of the laminated film).

It is not preferable when the T_{gc} is less than $50 \times (1 + A_e/A)$ because it becomes larger when the temperature and frequency characteristics among the electrical characteristics of the condenser are defective. It is preferable that the thickness of the surface layer in the present invention be 30% or less of the thickness of the laminated

film. And it is not preferable when it is thicker than 30% because the electrical characteristics, such as the electrostatic capacity and the temperature and frequency characteristics, and the heat resistance are defective. Although the lower limit of the thickness is not limited in particular, it is not preferable when it is less than 0.005 μm because the effects for improving the self-healing properties are difficult to obtain.

[0018] Moreover, it is preferable that the dielectric tangent (25°C, 1 kHz) of the laminated film wherein the surface layer was laminated on at least one side of the film comprising the styrene polymer having a syndiotactic structure be 0.001 or less in the present invention. It is not preferable when the dielectric tangent (25°C, 1 kHz) is larger than 0.001 because the excellent electrical characteristics of the film comprising the syndiotactic polystyrene polymer affect the characteristics of the polystyrene resin of the laminated surface layer, whereby it is impaired.

[0019] Furthermore, as for the condenser using the metalized syndiotactic polystyrene laminated film wherein a metal thin film layer was formed on at least one side of these laminated films in the present invention, loss of lubricant in the condenser manufacturing process is suppressed and the condenser is outstanding in running properties; hence, variation in the characteristics of the resultant condenser is reduced and the yield is improved. Moreover, the

humidity resistance and self-healing properties of the resultant condenser are improved when a voltage is applied thereto.

[0020] [Practical Examples]

Although the present invention will now be described specifically in the practical examples, the present invention is not limited to these practical examples only. Moreover, a method for evaluating the film is shown below.

[0021] (1) Three-dimensional surface roughnesses $S_{\lambda a}$ and three-dimensional surface roughness S_{Ra}

The film surface was measured using a stylus-type 3-dimensional surface roughness gage (SE-3AK, made by Kosaka Laboratory Ltd.) along a measurement length of 1 mm at a cutoff value in the longitudinal direction of the film of 0.25 mm under [misspelled in original] conditions of 2 μ m needle radius and 30 mg load, divided into 500 points at 2 μ m pitches, and the height at each point was loaded into a 3-dimensional roughness analyzer (SPA-11). A similar operation to this one was continuously performed 150 times in intervals of 2 μ m in the cross direction of the film, e.g., over 0.3 mm in the cross direction of the film, and the data was loaded into an analyzer. Next, the $S_{\lambda a}$ and S_{Ra} were found using the analyzer(s).

[0022] (2) Glass transition temperature

This is measured at conditions including a speed of temperature rise of 20°C/min and a sample weight of 5 mg using a Thermoflex DSC-8230 made by Rigaku Corp.

[0023] (3) Dielectric tangent

The dielectric tangent was evaluated at 25°C and 1 kHz using a 4192A LF Impedance Analyzer made by Yokogawa-Hewlett-Packard Co.

[0024] (4) Running properties and shaving resistance

A film was made into a tape shape with narrow slits, this was run at high speed for a longitudinal time by being rubbed on a guide roll made of metal, and after this guide roll was abraded, the increase/decrease of the tension of the tape and the increase/decrease in the amount of white powder generated on the surface of the guide roll were evaluated at 5 levels, as shown below, respectively, and ranked.

(i) Running properties

Grade 1: large tension (extremely large amount of abrasions)

Grade 2: tension somewhat high (large amount of abrasion)

Grade 3: Moderate tension (some abrasion)

Grade 4: tension somewhat low (hardly any abrasion)

Grade 5: Low tension (no abrasion developed)

(ii) Shaving resistance

Grade 1: Extremely large amount of white dust generated

Grade 2: large amount of white dust generated

Grade 3: Some white dust generated

Grade 4: Hardly any white dust generated

Grade 5: No white dust generated

[0025] (5) Humidity resistance when voltage applied

A voltage of 100V (DC) was applied to a condenser in a 95% RH atmosphere and aged for 1,000 hours, and the percentage of change in the electrostatic capacity was measured using a 4192A LF Impedance Analyzer made by Yokogawa-Hewlett-Packard Co. This is denoted by $\Delta C/C$ (%). The smaller the percentage of change in this electrostatic capacity is, the more satisfactory the humidity resistance is. C is the electrostatic capacity before aging and ΔC is a value obtained by subtracting the electrostatic capacity after aging from the electrostatic capacity C before aging. Judgment was made according to a five-level evaluation, and ranked.

Grade 1: $-20 > \Delta C / C \geq -10$

Grade 2: $-10 > \Delta C / C \geq -20$

Grade 3: $-5 > \Delta C / C \geq -10$

Grade 4: $0 > \Delta C / C \geq -5$

Grade 5: $\Delta C / C \geq 0$

[0026] (6) Self-healing properties (SH properties)

A laminated film vapor deposited on one side with 600Å thick aluminum was cut into a 1 cm-square on one side, two pieces thereof were superpositioned, and further, inserted between rubber plates 2 cm on one side, and a 2 kg load was applied thereto. In this state, voltage was applied to the vapor deposited film to generate a breakdown, and the presence of self-healability was evaluated on twenty samples.

Grade 1: No self-healability

Grade 2: Hardly any self-healability

Grade 3: May be no self-healability

Grade 4: Nearly self-healable

Grade 5: Entirely self-healable

[0027] (7) Temperature characteristics

The temperature characteristics were evaluated by the dielectric tangent at 150°C and 1 kHz using the 4192A LF Impedance Analyzer made by Yokogawa-Hewlett-Packard Co. The dielectric tangent was evaluated at five levels, as shown below, and ranked.

Grade 1: 0.05 or greater

Grade 2: 0.01 to 0.05

Grade 3: 0.005 to 0.01

Grade 4: 0.001 to 0.005

Grade 5: Less than 0.001

[0028] Practical Examples 1 and 2, Comparative Example 1

(a) Preparation [misspelled in original as [adjustment]

| | |
|---|--------------------------------------|
| Vironal MD1200 (made by Toyobo Co., Ltd.) | 20 weight parts (solid content: 25%) |
| Water | 36 weight parts |
| Isopropyl alcohol | 36 weight parts |
| Benzyl alcohol | 8 weight parts |

[0029] (b) Manufacture of laminated film

Polymer chips wherein 4.0 weight parts of a polyethylene terephthalate (IV=0.2) containing 35% by weight of calcium carbonate fine particles (average particle diameter: 1.0 μm ; degree of

variation: 20%) as the protrusion-forming agent, were added to 100 weight part of a syndiotactic polystyrene (weight average molecular weight: 250,000) and polymer chips without any protrusion-forming agent added were mixed at ratios of 0.2 to 9.8 (Comparative Example 1), 0.5 to 9.5 (Practical Example 1), and 1 to 9 (Practical Example 2), subsequently dried, melted at 300°C, extruded from a T-die having a 200 µm-lip gap, adhered fast to a 40°C cold roll, and cold solidified to obtain a 44 µm-thick amorphous sheet. This amorphous sheet was preheated to 100°C first by a roll, then further heated using four infrared heaters having a 700°C surface temperature using a four-roll, drawn two-fold in the longitudinal direction at a film temperature of 139°C, and then 1.8-fold in the longitudinal direction again at 125°C. A coating liquid obtained according to (a) above was coated on both sides of this uniaxially drawn film in a bar coating method. Then, the film was preheated to 120°C in a tenter, drawn 2.0-fold in the transverse direction at a drawing temperature of 120°C, and drawn 1.6-fold again in the transverse direction at 150°C, and subsequently thermally fixed at 260°C. The overall thickness of the resultant laminated film was 4 µm, with the sum total of the thickness of the surface layer being 0.1 µm, which was a uniformly coated film. Aluminum was vapor deposited to 500Å on the coated side of the resultant film, and a wound film condenser prototype was made. The film and condenser characteristics are shown in Table 1.

[0030] Comparative Example 2

Except for mixing polymer chips wherein 3.5 weight parts of calcium carbonate fine particles (average particle diameter: 1.0 μm ; degree of variation: 20%), as the protrusion-forming agent, were added to 100 weight parts of a syndiotactic polystyrene (weight average molecular weight: 250,000) and polymer chips without any protrusion-forming agent added at a proportion of 0.5 to 9.5, by weight ratio, and using this mixture, the operation was carried out as in Practical Example 1. Aluminum was vapor deposited to 500Å on the coated side of the resultant film, and a wound film condenser prototype was made. The film and condenser characteristics are shown in Table 1.

[0031] Practical Examples 3,4 and Comparative Example 3

A mixture in which polymer chips wherein 3.5 weight parts of calcium carbonate fine particles (average particle diameter: 1.0 μm ; degree of variation: 20%), as the protrusion-forming agent, were added to 100 weight parts of a syndiotactic polystyrene (weight average molecular weight: 250,000) and polymer chips without any protrusion-forming agent were added at a proportion of 1 to 9, by weight ratio, and polyethylene terephthalate (IV=0.62) not containing a protrusion-forming agent and used as the surface layer were supplied to respectively to an extruder, melted, adhered so that the polyethylene terephthalate formed a surface layer on both sides inside the T-die, extruded through the T-die having a 200- μm lip gap, adhered fast to a 40°C cold roll in an electrostatic application

[misspelled in original] method, cold solidified, and a 44 μm amorphous laminated sheet was obtained. The sum total surface thickness was 5 μm (Practical Example 3), 11 μm (Practical Example 4), and 14 μm (Comparative Example 3). This amorphous sheet was preheated to 100°C first with a roll, then heated again using four 4 infrared heaters having a 700°C surface temperature, drawn 2.0-fold in the longitudinal direction at a film temperature of 139°C and then drawn 1.8-fold again in the longitudinal direction at 125°C. A coating liquid obtained according to (a) above was coated on both sides of this uniaxially drawn film in a bar coating method. Then, the film was preheated to 120°C in a tenter, drawn 2.0-fold in the transverse direction at a drawing temperature of 120°C, and drawn 1.6-fold again in the transverse direction at 150°C, and subsequently thermally fixed at 260°C. The overall thickness of the resultant laminated film was 4 μm . Aluminum was vapor deposited to 500Å on the coated side of the resultant film, and a wound film condenser prototype was made. The film and condenser characteristics are shown in Table 1.

[0032] Practical Examples 5,6 and Comparative Example 4

A mixture in which polymer chips wherein 3.5 weight parts of calcium carbonate fine particles (average particle diameter: 1.0 μm ; degree of variation: 20%), as the protrusion-forming agent, were added to 100 weight parts of a syndiotactic polystyrene (weight average molecular weight: 250,000) and polymer chips without any protrusion-forming agent were added at a proportion of 1 to 9, by

weight ratio, and polyethylene polyethylene-2,6-terephthalate not containing a protrusion-forming agent and used as the surface layer (Practical Example 5), 50 weight parts of terephthalic acid and 50 weight parts of isophthalic acid as the carboxylic acid constituents, and resins have different glass transition temperatures by changing the composition ratio of the ethylene glycol and 1,4-cyclohexane dimethanol (Practical Example 6, Comparative Example 4) were supplied to respectively to an extruder, melted, adhered so that the polyethylene terephthalate formed a surface layer on both sides inside the T-die, extruded through the T-die having a 200 μm -lip gap, adhered fast to a 40°C cold roll in an electrostatic application [misspelled in original] method, cold solidified, and a 44 μm amorphous laminated sheet was obtained. Here, the sum total surface thickness was 1 μm . This amorphous sheet was preheated to 100°C first with a roll, then heated again using four infrared heaters having a 700°C surface temperature, drawn 2.0-fold in the longitudinal direction at a film temperature of 139°C and then drawn 1.8-fold again in the longitudinal direction at 125°C. A coating liquid obtained according to (a) above was coated on both sides of this uniaxially drawn film in a bar coating method. Then, the film was preheated to 120°C in a tenter, drawn 2.0-fold in the transverse direction at a drawing temperature of 120°C, and drawn 1.6-fold again in the transverse direction at 150°C, and subsequently thermally fixed at 260°C. The overall thickness of the resultant laminated film

was 4 μm . Aluminum was vapor deposited to 500Å on the coated side of the resultant film, and a wound film condenser prototype was made. The film and condenser characteristics are shown in Table 1.

[0033] [Table 1]

| | T _g | SH ₁ | SH ₂ | 厚度比 | 透過正接 | 耐油性 | 削れ性 | 湿度耐性 | 特性 |
|------|----------------|-----------------|-----------------|------|--------|-----|-----|------|-----|
| | °C | μm | μm | a % | b | c 級 | d 級 | e 級 | f 級 |
| 比較例1 | 67 | 0.009 | 8.4 | 2.5 | 0.0005 | 2 | 3 | 5 | 4 |
| 実施例1 | 67 | 0.014 | 9.0 | 2.5 | 0.0005 | 3 | 4 | 5 | 4 |
| 実施例2 | 67 | 0.035 | 9.5 | 2.5 | 0.0005 | 4 | 5 | 5 | 4 |
| 比較例3 | 67 | 0.041 | 20.4 | 2.5 | 0.0005 | 5 | 2 | 5 | 3 |
| 実施例3 | 69 | 0.037 | 17.3 | 11.4 | 0.0005 | 5 | 4 | 4 | 5 |
| 実施例4 | 69 | 0.039 | 12.3 | 25.0 | 0.0005 | 3 | 5 | 4 | 5 |
| 比較例5 | 69 | 0.022 | 7.0 | 21.8 | 0.0011 | 4 | 4 | 4 | 5 |
| 実施例5 | 113 | 0.029 | 12.1 | 25.0 | 0.0007 | 4 | 5 | 4 | 4 |
| 実施例6 | 65 | 0.038 | 10.2 | 25.0 | 0.0008 | 3 | 4 | 4 | 5 |
| 例4 | 62 | 0.036 | 10.1 | 25.0 | 0.0008 | 3 | 4 | 4 | 5 |

Key: a) Thickness Ratio %; b) Dielectric tangent; c) Running properties Grade; d) Shaving Resistance Grade; e) Humidity Resistance Grade; f) SH Properties Grade; g) Temperature Characteristics Grade; h) Comparative Example; i) Practical Example

According to Table 1, the films obtained in Practical Examples 1 to 6 were syndiotactic polystyrene laminated film and condensers having outstanding film running properties and shaving resistance during manufacture of the film and manufacture of the condenser, and improved humidity resistance and self-healing properties when a voltage was applied.

[0034] [Advantages of the Invention]

As described above, the present invention adopts a configuration, as described in the aforesaid Claims, whereby a syndiotactic polystyrene laminated film and condenser outstanding in film running properties and shaving resistance during manufacture of the film and

manufacture of the condenser, and improved humidity resistance and self-healing properties when a voltage was applied were provided. Therefore, the industrial value of the present invention is large.